National Aeronautics and Space Administration

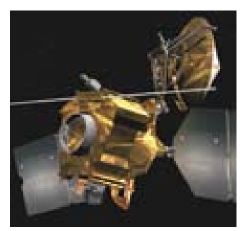
The NESC's mission is to perform value-added independent testing, analysis, and assessments of NASA's high-risk projects to ensure safety and mission success. We engage proactively to help NASA avoid future problems.

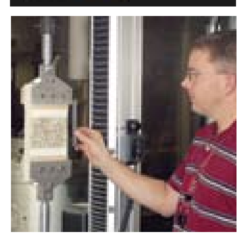
NASA

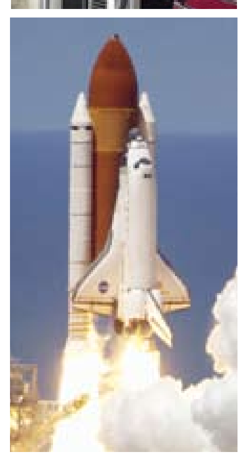
Artist's rendition of the Crew Exploration Vehicle (CEV) docking with the International Space Station. Work being performed by the NESC will help to fulfill the goals of the Vision for Space Exploration.

NESC Supporting the Constellation Program

The NESC has been increasingly involved in supporting the Constellation Program's Crew Exploration Vehicle (CEV) and Crew Launch Vehicle (CLV) Projects. A CEV Smart Buyer Design Team was formed and used the organizational structure of the NESC to bring together specialists from across the Agency (both inside and outside of the NESC) to produce a detailed and innovative CEV design to assist the Project in identifying driving requirements. This effort not only produced alternative concepts for the CEV Project to evaluate, but also demonstrated that NASA has the in-house capability to perform a multi-Center, integrated design. Three NESC assessments developed from the Smart Buyer activity: a project to evaluate the relative merits of landing in water versus landing on land; an examination of the aerodynamic characteristics of different Launch Abort System configurations, and an assessment of the advantages and feasibility of a composite crew module. Other NESC efforts supporting the CEV include a periodic review of the aero databases and models used to validate the CEV design and a study of the best practices for successful design of human-rated spacecraft. The NESC has also been involved with the planning and design of the CLV by providing expertise to help size the reaction control system for vehicle roll control and to evaluate proposed launch vehicle design concepts.





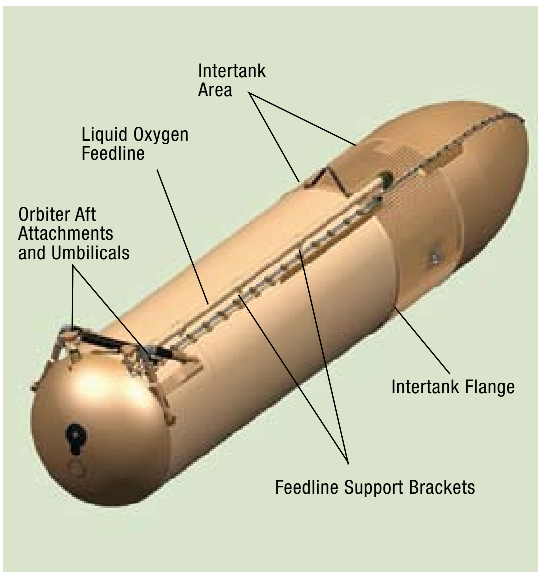


NASA engineering and safety center

Reducing Foam Loss from the Space Shuttle External Tank Intertank Flange Region

The Shuttle External Tank (ET) intertank flange area is known to release pieces of foam during ascent which can strike and damage the orbiter's thermal protection system. The NESC is proactively developing designs to mitigate this problem. The intertank area separates both the cryogenic liquid oxygen and liquid hydrogen tanks and is purged with gaseous nitrogen to maintain safe oxygen levels when propellants are present. When the nitrogen contacts the few areas of the cryogenically-cooled hydrogen tank that cannot be insulated with foam, it condenses and is "cryo-ingested" into voids within the ET's external foam layer via the hydrogen tank mounting flange. One theory is that the liquid nitrogen in the voids expands on ascent and can liberate foam from the ET. The ET Project has implemented improved foam application processes which minimize voids in the foam.

The NESC has performed a series of cryogenic developmental tests on a simulated scale ET intertank flange to demonstrate the effectiveness of using Nanogel® insulating beads in reducing cryo-ingested nitrogen and subsequent ET foam loss. Test results are being shared with the Space Shuttle Program (SSP) and efforts are underway to perform the next level of tests on flightlike hardware. The NESC will provide recommendations to the SSP regarding Nanogel® bead characteristics for any upcoming tests.



Shown above are the areas of the ET where the NESC is working to reduce ice build up and foam loss.


NESC

Glenn Durell *(left)* and Mike Ferrick *(right)* of the U.S. Army's Cold Regions Research & Engineering Laboratory, Hanover, N.H., examine a double lap shear test coupon coated with SILC after a test at -170°F.

NESC Develops Innovative Coatings to Reduce Ice Growth and Adhesion

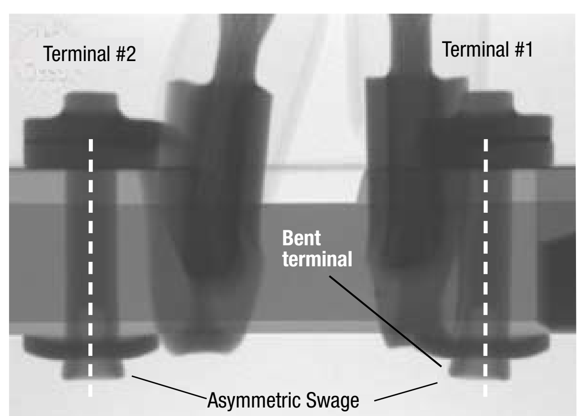
The NESC has been working to reduce the growth of potentially damaging ice that can develop on components of the Space Shuttle's External Tank (ET) including areas along the cryogenic liquid oxygen feedline bellows and support brackets. Ice debris can potentially damage the orbiter during ascent. A coating to reduce ice adhesion was developed by the NESC team (patent being filed) and was tested on multiple substrate materials at temperatures down to -170°F. The coating, Shuttle Ice Liberation Coating (SILC), reduces the ice adhesion strength substantially on all surfaces, with a 75 to 100% reduction in adhesion strength. SILC could be applied to surfaces on the orbiter and ET that would benefit from early ice liberation. Early release of ice can help to mitigate the risk of ice debris impacting on the orbiter.

Other ice mitigation activities include the development and testing of a flexible polyimide foam segment to insulate the area between the bracket and the feedline to allow movement between the bracket and feedline without damaging the insulation currently used on the ET.

Space Shuttle Engine Cutoff Sensor Anomaly and Reliability Investigation

The NESC was part of a team to determine the root cause of the anomalous behavior observed in the Space Shuttle Engine Cut-Off (ECO) sensor system during External Tank (ET) tanking tests and launch attempts on STS-114. A theory was developed that would explain how a sensor could show an apparent failure on first exposure to liquid hydrogen (LH2), but show no indication of anomalous behavior when returned to ambient temperature or on subsequent exposure to LH2.

The team performed cryogenic cycling of 50 fully instrumented recent vintage (2002-2003) flight grade sensors between ambient and LH2 temperatures to determine the validity of the theory. It was noted that the STS-114 ECO sensors were of an earlier vintage. Both non-destructive and destructive physical analysis techniques were employed to characterize the sensors. While all sensors behaved nominally, nondestructive and destructive physical analysis indicated some issues with the material selection and process variability used in the fabrication of a swaged circuit board terminal connection that could be highly sensitive to human factors in the assembly process and result in lot-to-lot variability.

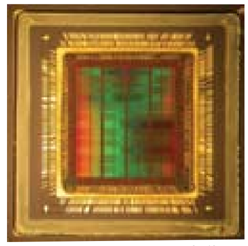


GSFC

Manufacturing issues in an ECO sensor electrical terminal connections are visible in this x-ray.

Field Programmable Gate Array (FPGA) Risk Reduction and Programmed Antifuse Reliability Evaluation

Multiple projects across the Agency will soon use 0.25-micron technology Radiation Tolerant (RT) Field Programmable Gate Arrays (FPGAs) to implement digital circuitry for flight applications. They offer significant advantages over previous versions in terms of capacity and capability. However, field failures in 2003 identified problems on the SX-S series parts. At that time, many NASA applications using the SX-S were under development, causing significant cost impacts and higher mission risks. In response to these failures, the FPGA manufacturer instituted device foundry changes and antifuse programming algorithm changes.



NASA/OLD

RTAX-S FPGA showing package cavity, die, and wire bonds.

The NESC sponsored evaluation studies of the SX-S changes. Early test results indicate improved SX-S reliability. The NESC is also sponsoring reliability evaluation and risk reduction testing of the new RTAX-S parts with the goal of accelerating the detection of any problems. The RTAX-S provides greater capability and improved resistance to electrostatic discharge. An NESC Agency-wide team is engaged to review results. Overall, the results from the SX-S and RTAX-S testing will benefit NASA by reducing risk through identifying problems (if any) early enough to allow projects to more effectively resolve them.

Video: Mike Taylor/Utah State University.

Video frame *(Above)* from spotting camera onboard the NASA DC-8. Evident in the image is the trail, or wake train, which was also visible to the eye. An artist's rendering *(Right)* of the SRC reentry.

Stardust Reentry Aerothermal Observation Campaign

On January 15, 2006, the Stardust Sample Return Capsule (SRC) successfully returned its cargo of cometary particles to Earth. As the SRC entered at 12.8 km/s, the fastest man-made object to traverse our atmosphere, an NESC sponsored team of researchers imaged the event aboard the NASA DC-8 airborne observatory. The purpose of the observation campaign was to calibrate aerodynamic, aerothermodynamic, and thermal protection system material response models with actual reentry data.

With the SRC not having any on-board flight instrumentation, these data are the only time resolved record of the performance of the entry system. The radiative signals from the SRC and surrounding shock layer gasses were measured by 15 of 18 instruments that had various combinations of spectral range, spectral resolution, and temporal resolution. The data were assessed to be of very good quality and sufficient to address all observation objectives: absolute radiance, spectral resolution of shock layer emission, and wake train evolution. Analysis of these observation data and the recovered SRC heatshield will provide an assessment of the fidelity of the aerodynamic, aerothermodynamic, and thermal protection system material response models and ground tests used to design the SRC. This assessment directly supports the Exploration initiative in that these models and tests are being used in the design of the Crew Exploration Vehicle.

Space Shuttle Solid Rocket Holddown Post Stud Hang-up Root Causes

An NESC assessment was initiated to determine the root cause(s) of recurring Solid Rocket Booster (SRB) stud hang-ups. The SRBs are bolted to the Mobile Launch Platform by a Holddown Post (HDP) system. At the time of launch, these bolt studs are designed to quickly exit into the HDP allowing the Space Shuttle to liftoff. A stud hang-up at liftoff can increase loads at the SRB/External Tank attach points.

The NESC undertook an extensive hardware test program to aid in determining root cause. This included developement of a high fidelity stud and frangible nut model that was calibrated with data from the test project. The NESC found that a number of often violent factors work to slow or interrupt the stud's descent and clearance from the SRB. The cause of stud hang-ups is a combination of contributing factors including: frangible nut pyrotechnic firing skew, nut half recontact, plunger seating and frangible link breakage, debris interaction, bore hole contact, frictional forces from the plunger, and movement of the SRB aft skirt prior to full stud ejection. At launch, the cumulative result of the factors' individual effects on the stud, most of which are almost always in play but take place at variable levels of intensity, add up to slow down the stud's descent enough that a hang-up occurs. The Space Shuttle SRB Project can now work toward modifications that reduce the number of these unwanted occurrences.

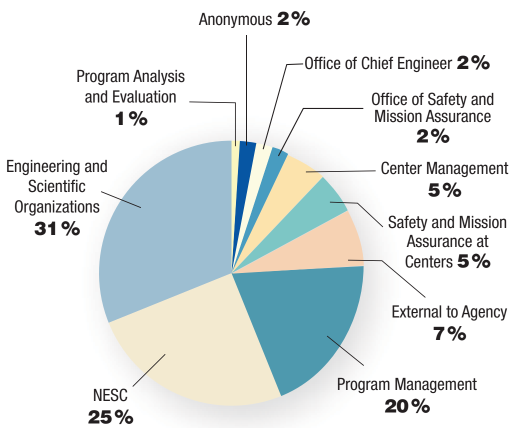
Pictured *(left)* is a test fixture with a frangible nut. Extensive testing, modeling and simulation was used to determine the causes of the stud hang-ups.

NESC

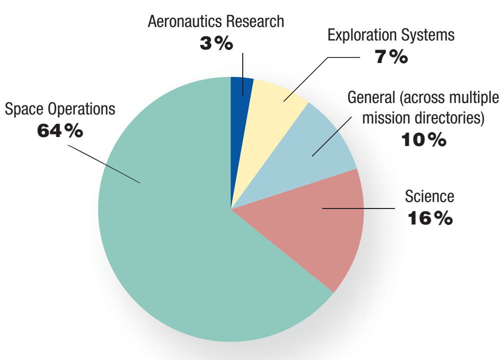
Metrics

As of June 30, 2006, the NESC applied its technical expertise to 137 requests.

Source of Accepted Requests *(Cumulative)*



Accepted Requests by Mission Directorate *(Cumulative)*



For more information on the NESC, the contents of this brief, or to report a technical concern please visit **http://nesc.nasa.gov**
For position opportunities with the NESC please visit **www.usajobs.com**

NESC Awards

NESC honor awards are presented to individuals and teams who contributed significantly to the NESC mission.

KSC

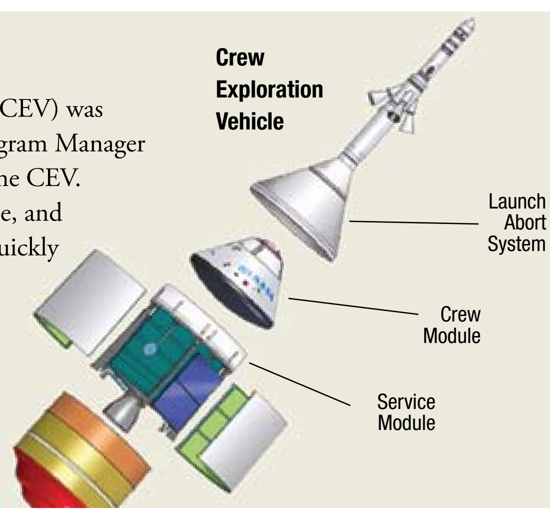
Orlando, Fla. January 31, 2006: From left: Jerry Ross (NESC Chief Astronaut/presenter), Dr. Vickie Parsons (LaRC retired), Phillip Hall (MSFC), Paul Roberts (LaRC), Steve Gentz (LaRC), Erin Moran (Swales Aerospace), Roy Hampton (ARC retired), Dr. Rebecca MacKay (GRC), David Lowry (JSC), Dr. John Lin (LaRC), Dr. Norman Knight (General Dynamics), Terresita Alston (Remtech Services), Ralph Roe (NESC Director/presenter).

Learning from the Past, Looking to the Future with the NESC Academy

The NESC Academy celebrated its first year and is enjoying a great success on the heels of its first four, three-day course offerings by NESC experts in: Space Life Support Systems (Hank Rotter), Propulsion Systems (George Hopson), Power and Avionics (Robert Kichak), and Satellite Attitude Control Systems (Neil Dennehy). The mission of the Academy is to capture, share and preserve the lifetimes of experience and knowledge of the NESC's senior scientists and engineers. A typical student testimonial included, " ... as we lose people to retirement... I think this is a great way to capture that knowledge and to pass it on to us as we grow as engineers...." Visit the Academy website to learn more about the Academy and how to take the first three courses as on-line, self-paced courses (www.nescacademy.org).

CEV Smart Buyer Team Honored by NESC

An intense 8-week Agency-wide design study of the Crew Exploration Vehicle (CEV) was recently completed. A team was formed at the request of the Constellation Program Manager to identify major design drivers and to develop innovative design concepts for the CEV. The study was divided into three major elements: Crew Module, Service Module, and Launch Abort System. Portions of the NESC business structure were used to quickly assemble the CEV Smart Buyer Team, which included over 200 members with representation from each of NASA's 10 Centers and Headquarters. The NESC formally acknowledged the contributions of this team by awarding them the NESC Group Achievement Award for exemplary efforts in the creation of an innovative, detailed, in-house design of the CEV.



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